CHAPTER 7

Contextual Challenges of Developing Effective Water Management Institutions: The Deduru Oya Basin, Sri Lanka

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Introduction

This paper analyzes the institutional problems related to water resources management in the Deduru Oya river basin, the fifth largest river basin in Sri Lanka, and proposes institutional reforms required for better management of water resources. Institutions in this context include policies, rules, regulations and rights, and organizations that are required to plan and implement activities to address the problems related to water resources management in a river basin context. To understand the problems related to sustainable management of water resources, for irrigated agriculture in particular and other uses in general in a river basin context, the research adopted a multidisciplinary and multi-analytic approach whose framework is presented in figure 1.

Methods Used for Data Collection

Primary and secondary data were collated for the analysis of various components of the study. The existing secondary data held by government agencies operating in the basin were used for the identification of the physical features of the basin. The data on physical characteristics were supplemented by field visits made to locations representing specific features, problems and important issues of water resources management. Data available at the agencies including the Irrigation Department, Meteorological Department and Land Use Planning Department were used for water accounting. Secondary data available in the offices of the Divisional Secretaries were used for identification of socioeconomic features in the basin. For analyzing the performance of irrigated agriculture the secondary data available at agencies, such as the Department of Agriculture, were used. Field trips to the basin helped develop better understanding of different water user sectors and their locations in the basin. Agriculture under small tank systems was analyzed by a sample household survey.

The most important component of the study, stakeholder consultation, was carried out through participatory rural appraisal sessions (PRAs) held with different water users in the basin. Existing government agencies were actively involved in helping organize meetings with different stakeholders for focus group discussions and workshops. This provided an

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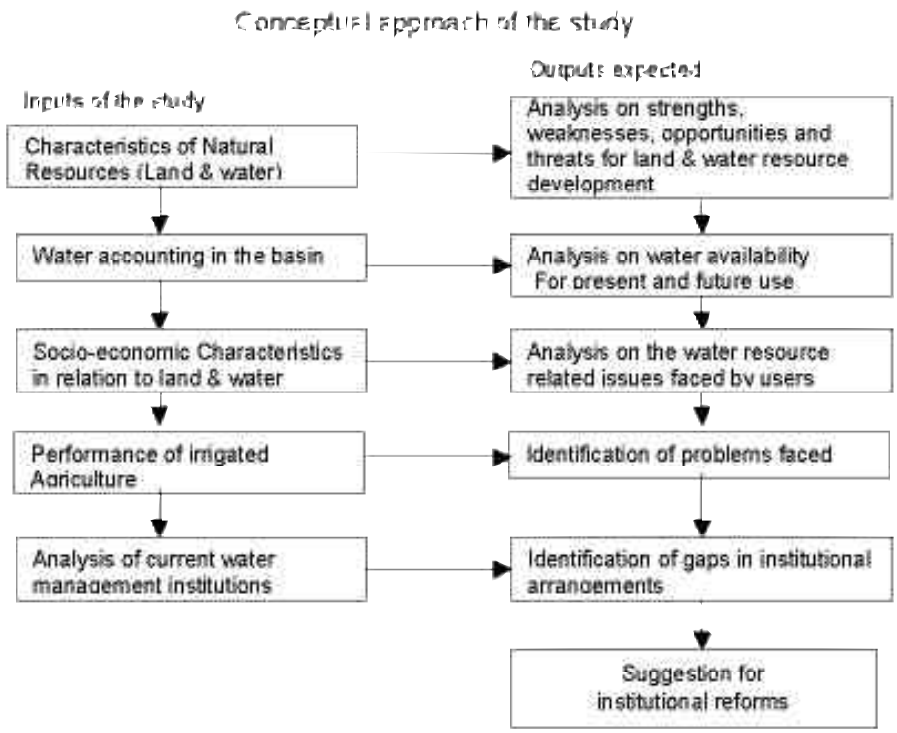
Figure 1. Framework adopted in the study.



opportunity for stakeholders to discuss and share views on problems related to water resources management and to understand the concept of integrated water resources management in a river basin context. PRAs provided an opportunity for these groups to propose solutions for the emerging water-resources problems.

Physical Characteristics

This section describes the physical characteristics of the basin. In addition, water accounting describes existing water use and verifies the availability of water resources in the basin for future development.

Existing Natural Resources

Water resources. Rainfall is the only source of water for the Deduru Oya river basin. Water users in this basin benefit from direct rainfall, streamflow consisting of direct runoff and base flow or groundwater discharge, surface water storage in reservoirs and groundwater storage. The average monthly rainfall is presented in table 1. In an average year the basin area receives a monthly rainfall ranging from 108 mm to 280 mm from September to December. This period known as the *maha* (wet) season is the main cultivation season in the country. The period

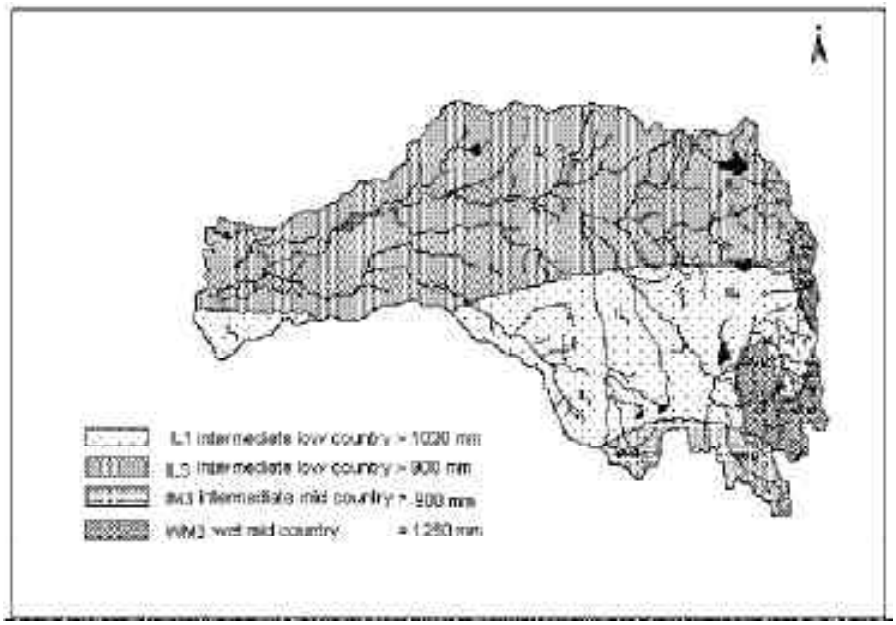
Table 1. Pump irrigation schemes in the basin

Divisional Secretariat (DS) Division	# of pumps	Maha Extent (ha)	Yala Extent (ha)
Mawathagama	41	35.2	20.7
Polpithigama	787	342.5	438.0
Ridigama	161	117.4	113.4
Ibbagamuwa	130	125.5	57.1
Ganewatta	194	219.8	126.0
Kobeigane	780	451.5	643.0
Wariyapola	1	60.7	20.2
Bingiriya	240	316.6	194.0
Total	2,334	1,669.2	1,612.4

Source: ECL report on Deduru Oya river basin profile, 1999.

from March to June is known as the *yala* (dry) season and is characterized by low rainfall. The basin area falls under two climatic zones, wet and intermediate and its subgroups as shown in figure 2. There is a significant variation in rainfall in these three zones. The upper watershed area of the basin in the wet zone generates runoff, which flows into the lower portion of the basin.

Figure 2. Agro-ecological regions in the Deduru Oya basin.

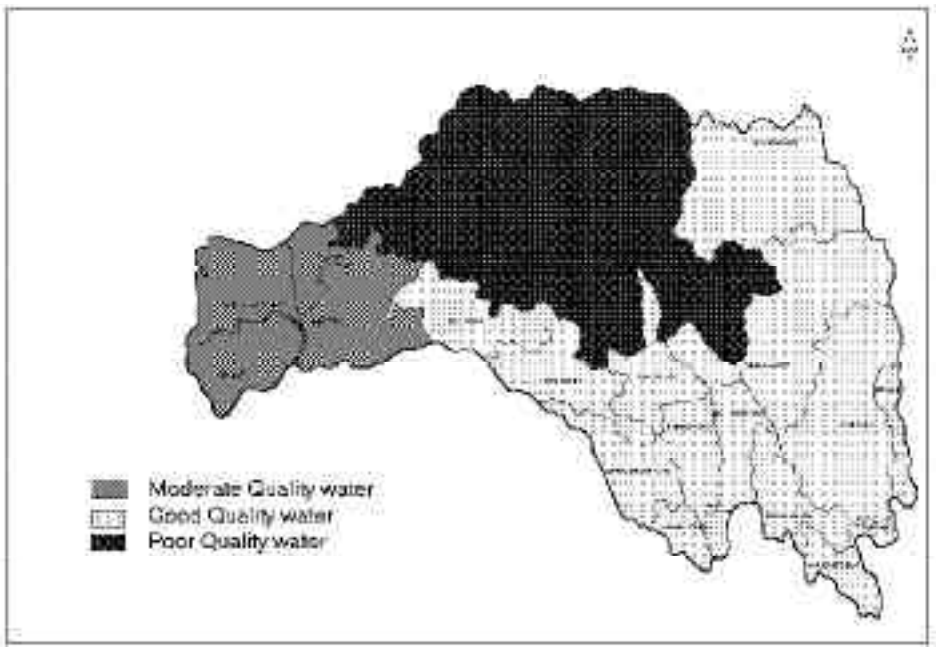


There are no significant variations in the temperature over the year. It varies between 25 ºC and 30 ºC within a year. Similarly, spatial variation of the temperature is also not significant in the basin.

Deduru Oya river (surface water resources). The Deduru Oya originates in the Matale hills (in the wet zone part of the centrally located hills in the country) and the basin extends to over 2,622 km^2. It has 15 sub-watersheds. Water-related development activities in the basin are heavily dependent on the hydrology of the river and streams. For example, the major irrigated agricultural schemes are located in sub-watersheds endowed with an abundant water supply. During the wet season, the river discharges a substantial quantity of water out of the basin. The figures for the period 1951–1978 indicate that annual discharge varies from 900 million m^3 (MCM) to 2,000 MCM. It should be noted however that discharges are confined to the period from September to December.

Groundwater. The western downstream portion of the basin with a deep weathered soil profile and sandy soils is capable of retaining a substantial amount of groundwater in the regolith. The north-central part of the basin (i.e., Wariyapola, Nikaweratiya and Mahawa areas) has a comparatively thin regolith soil profile and, therefore, less groundwater potential. A common feature of this part of the basin is the poor quality of groundwater in terms of salinity, hardness and fluoride and iron content due to low circulation of groundwater. The degree of the quality of water is shown in figure 3.

Figure 3. DS divisions and degree of quality of water in Deduru Oya.



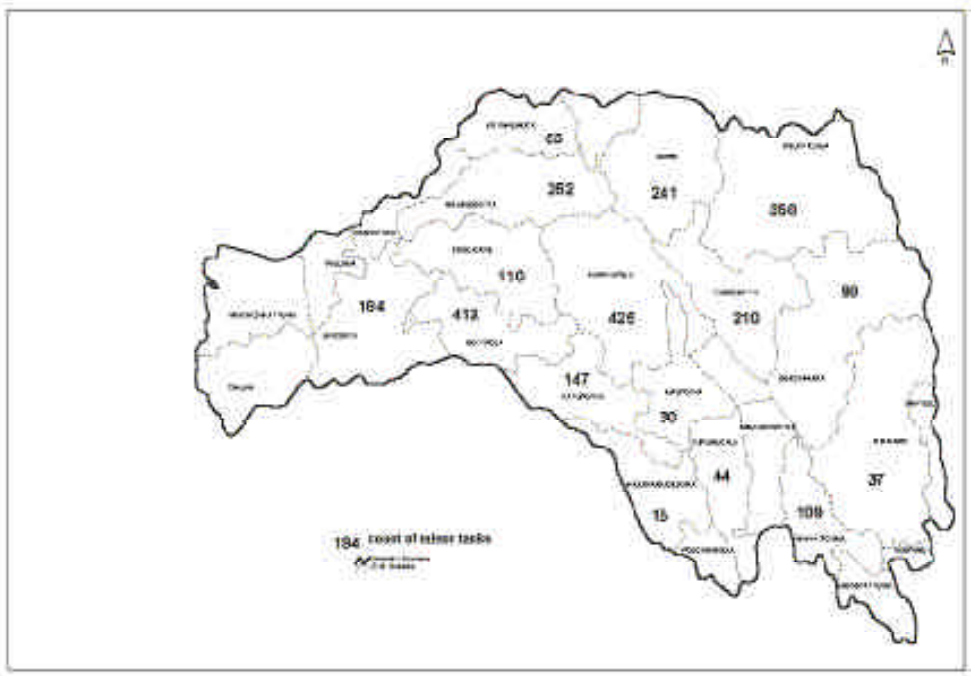
Soil types in the basin. About 38 percent of the basin area consists of red yellow podzolic soil. Water availability in such soil, 15cm/m is better than that of the other soil types in the basin. The second dominant soil type, which accounts for 36 percent of the basin area, is noncalcic brown soil that has a water-holding capacity of 11 cm/m.

Other natural resources in the basin area. About 91 percent of the land area in the basin is utilized for various types of development activities. The remaining land area comprises forests, classified as dense forest (1.6%), open forest (0.4%), scrub (1.5%), grass (0.02%), both natural and manmade water bodies (4.4%), barren land (0.5%), mangroves (0.03%) and marshy land (0.02%). The total undeveloped land area, which is about 22,440 hectares, is equal to 9 percent of the total land area developed in the basin.

Physical Characteristics of Water Resources Development in the Basin

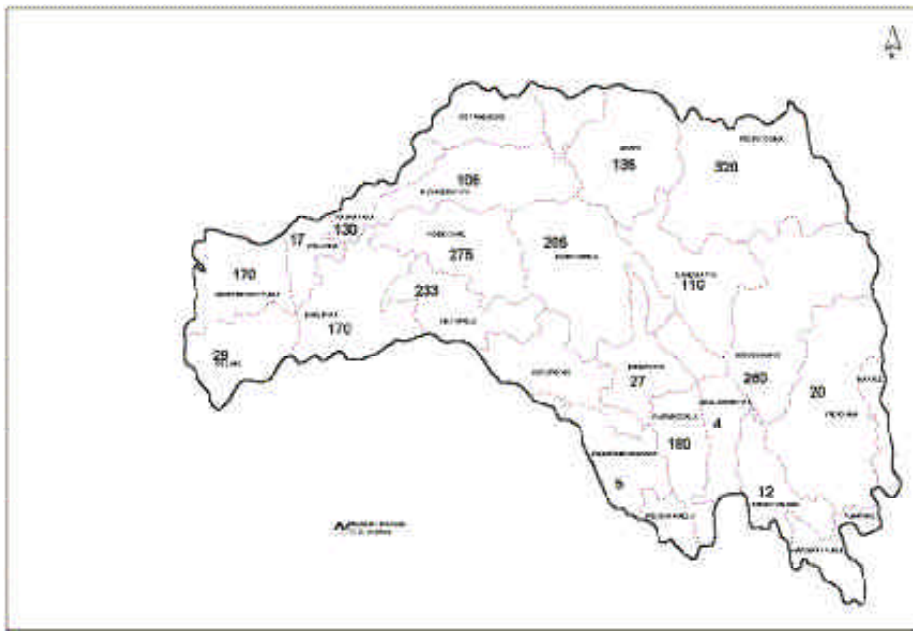
Irrigation systems. There are seven major and medium reservoirs constructed in the basin area to supply water for irrigated agriculture. About 6,320 hectares are cultivated under these tank systems. In addition, there are about 1,560 small village tanks serving nearly 12,000 hectares. These tanks have been registered in the Department of Agrarian Services. An equal number of small village tanks that are not registered in the government records exist in the basin. These tanks constructed by the farmers are farmer-managed and receive assistance from NGOs for major repair and rehabilitation activities. Figure 4 shows the Deduru Oya DS divisions and the distribution of minor tank systems.

Figure 4. Deduru Oya DS divisions and distribution of minor tank systems.



Groundwater extraction (agricultural wells). Extraction of groundwater through agricultural wells is an expanding water resource use in the basin. Most of the people tapping groundwater are the second- and third-generation members of farmer families without access to land and water in major, medium or minor tank systems. Some farmers cultivating under minor tank systems have wells in their paddy lands used for supplementary irrigation. In the yala seasons some farmers use them to raise other field crops (OFCs). Most of these wells have been constructed by farmers with assistance from the government or foreign-funded rural development projects. They are owned by farmers individually. The spatial variation of agricultural wells in the basin is shown in table 4. Farmers in the dry-zone areas of the basin tend to use them as a supplementary source of irrigation. At present, there are about 2,450 agro-wells in the basin and the number is increasing annually. The Deduru Oya DS divisions and agro-wells are presented in figure 5.

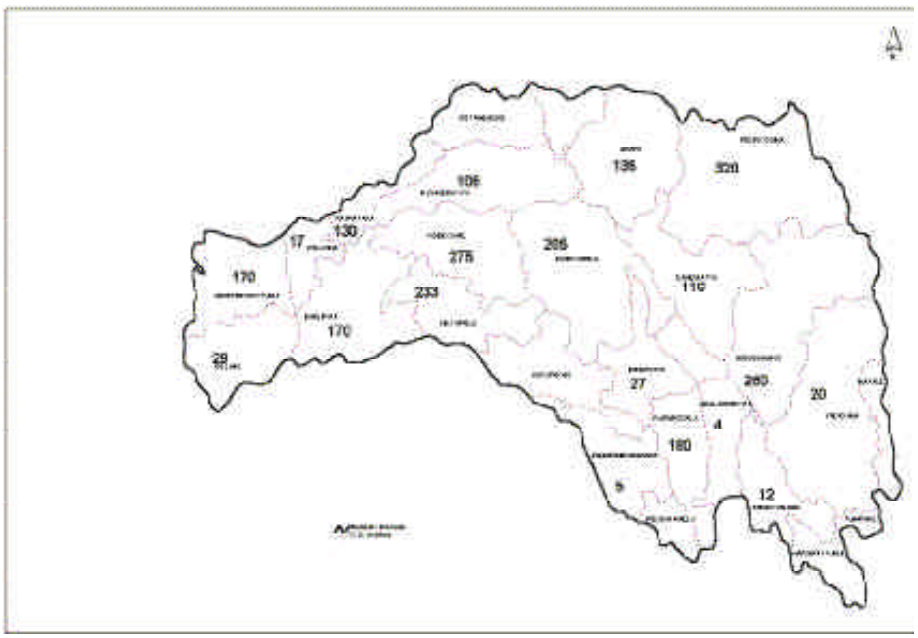
Figure 5. Agricultural wells in the basin.



Lift irrigation schemes. Lift irrigation is another means of extracting surface water for agriculture. There are lift irrigation schemes in the basin serving farmer groups formally recognized by the government. Also there are individual farmers tapping water in the river and its tributaries using water pumps. All these farmers are concentrated in areas below diversion points of the major irrigation schemes of the river. Farmers resort to lift irrigation for cultivation, as they have no access to water in the tank system. However, their operations are limited to periods when there is a base flow in the river. Farmers tapping water through lift irrigation have serious

problems at present due to the deepening of the riverbed as a result of excessive sand mining. The farmers using lift irrigation in downstream areas have problems of water quality due to intrusion of seawater. Details of these pumps and their spatial distribution in the basin are shown in both table 1 and figure 6.

Figure 6. Map of Deduru Oya indicating lift irrigation systems.



Domestic water (drinking)-supply schemes in the basin. Those with access to pipe-borne water supply amount only to 5 percent of the population in the basin. Drinking water is a serious problem for a third of the basin population, in the middle part of the basin area falling within the dry zone. This is mainly due to the shortage of groundwater and its poor quality in this part of the basin. Although there is a tributary of the Deduru Oya in this area, it cannot be used for augmenting drinking water supply schemes due to pollution. This tributary running through the Kurunegala town, the main city of the northwestern province, gets polluted due to wastewater and sewage discharge. The tail-end portion of the basin also has problems of drinking water due to salinity in the resources of groundwater and surface water. Only about 37 pipe-borne water supply schemes and 1,199 tube wells are available for the whole basin to provide drinking water to the communities in the basin area. There are no separate schemes or infrastructure to supply water for industries, livestock and other uses. The agricultural wells and other drinking water sources are used for these purposes.

Land development (existing land-use pattern). A large part of the basin consists of coconut plantations, representing about 36 percent of the total land area in the basin. The second largest land-use category is paddy lands, covering 17 percent of the land area in the basin. Nearly 14 percent of lands are home gardens, concentrated mainly in rural areas.

Water Accounting (Water Use for a Variety of Development Activities)

Major cultivation seasons in the basin are maha and yala seasons as indicated above. Paddy, which is the main crop grown under irrigation in the basin, requires irrigation. Other tree crops such as coconut and rubber do not require irrigation water although they consume a substantial quantity of water from the basin. Water accounting for yala and maha seasons shown in table 2 is based on observed cropping intensities and water consumption by forests and natural vegetation. The information in table 2 indicates that during maha seasons, a substantial quantity of water flows out of the basin ranging from 400–1,300 MCM.

Performance indicators. According to the indicator values given above, when net Depletion Fraction $(DF)_{(net)}$ <1 the basin is open and some utilizable water flows out of the basin. Available water was fully utilized only in two seasons, yala 1994 and yala 1996. Depleted Process Fraction indicates the efficiency of water use in the basin. Process Fraction in the range of 0.49–0.75 means that there is a possibility for the development of water utilization in the basin. But these values give only a general idea of the hydraulic behavior of the basin. Qualitative information gathered during the collection of field data and the actual field data shows that more runoff occurs in upstream areas located in the wet zone. The middle and tail-end parts of the basin, located in the intermediate zone, face water shortage problems in dry periods. These spatial variations in the basin need to be considered in the plans for increasing water use efficiency in the basin.

Socioeconomic Characteristics

Population

Table 4 presents the total population and population density in the basin area falling under each DS division. The special characteristic of the basin is the concentration of the population in its head- and tail-end parts. These head-end areas include the Kurunegala town, which is the main city of the Kurunegala district and its adjoining suburban areas such as Mallawapitiya, Mawathagama and Maspotha DS divisions. In the tail end, the Chilaw town located in the coastal belt has a high population density. Except for the people in the areas under these two major towns, the majority of the rest of the people are rural communities living in villages or small peasant townships. The lowest population values are reported from the dry-zone areas, Maho, Kotawehera and Nikaweraitya DS divisions in the basin. Analysis of data on population growth shows that the growth rate in the basin area is more or less equal to the national growth rate, that is 1.5. Of the population 40 percent are in the age group of 19–45 years while the population below 5 years and between 6–18 years is 11 percent and 26 percent, respectively. Those above 45 years of age constitute 24 percent of the total population of the basin area.

Table 2. Basin water accounting (in MCM).

Climatic Condition	1994	94/95	1995	95 /96	1996	96/97	1997	97/98	1998
	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
(Data in MCM)	Dry	Average	Wet	Dry	Average	Dry	Wet	Wet	Wet
Gross inflow	1,202	2,071	2,005	1,578	1,745	1,558	2,172	3,031	2,010
Storage changes	259	-179	71	9	40	-40	-9	-150	150
Net inflow	1,407	1,891	2,076	1,587	1,785	1,518	2,163	2,880	2,160
Process depletion	615	985	1019	842	840	968	967	1109	969
Non-process depletion (beneficial)	245	305	386	205	401	205	392	319	392
Non-process depletion (non-beneficial)	243	196	255	192	485	116	350	135	299
Uncommitted outflow	358	406	416	349	85	230	454	1318	500

Table 3. Basin water performance indicators.

Season and	1994	94/95	1995	95 /96	1996	96/97	1997	97/98	1998
Climatic	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
Condition	Dry	Average	Wet	Dry	Average	Dry	Wet	Wet	Wet
$DF_{(gross)}$	0.92	0.72	0.83	0.78	0.97	0.83	0.79	0.52	0.83
$DF_{(net)}$)	0.76	0.79	0.80	0.78	0.95	0.85	0.79	0.54	0.77
$DF_{(avail)}$	0.76	0.79	0.80	0.78	0.95	0.85	0.79	0.54	0.77
$PF_{(depleted)}$	0.56	0.66	0.61	0.68	0.49	0.75	0.57	0.71	0.58
$PF_{(avail)}$	0.51	0.52	0.49	0.53	0.47	0.64	0.45	0.38	0.45
Overall cropping intensity	0.39	0.84	0.65	0.43	0.23	0.74	0.45	0.97	0.34

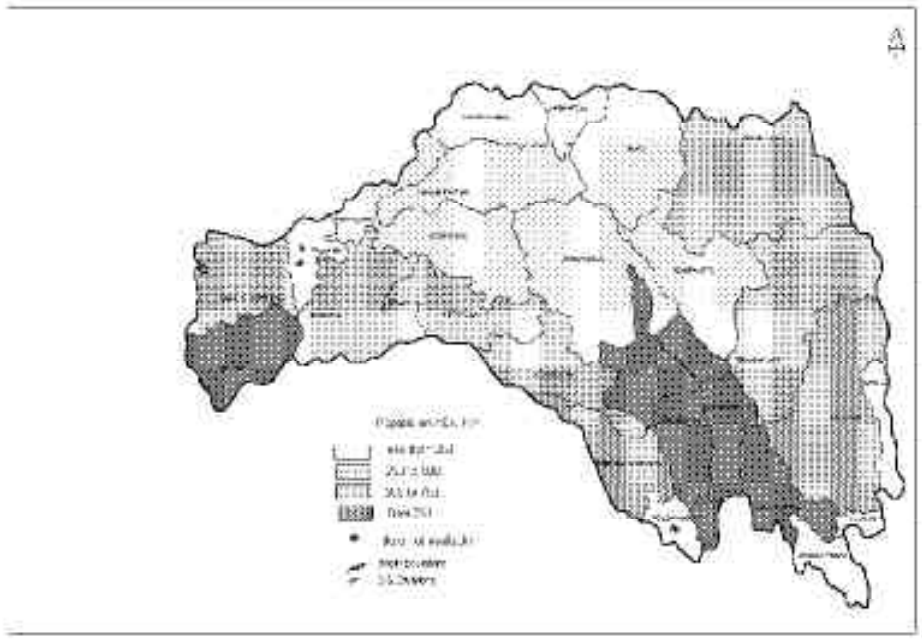
Table 4. Population and population density.

DS Division	Basin Population	Area under the DS Division (km^2)	Population Density (Persons/ km^2)
Ridigama	89,848	132.4	681
Mawathagama	57,464	68	845
Polgahawela	10,394	na	Na
Polpitigama	61,465	234.4	336
Ibbagamuwa	84,486	194	435
Mallawapitiya	43,835	47.5	923
Kurunegala	87,465	107	819
Weerabugedara	30,922	59.6	519
Ganewatta	38,010	191.2	199
Maspotha	40,551	45.5	891
Maho	52,934	247.5	214
Wariyapola	57,298	99.4	293
Katupotha	20,554	119.4	286
Kotawehera	20,310	266.2	176
Nikaweratiya	36,617	181	214
Kobeigane	33,549	125.6	267
Hettipola	71,120	202.3	352
Rasnayakapura	21,646	132	164
Bingiriya	56,000	185.9	377
Pallama	4,001	na	Na
Aracchikattuwa	19,430	115.2	337
Chilaw	24,768	80	751
Total	962,667	2,754[a]	310 [a]

These values indicate that the members of the younger generation below 18 years of age dependent on adults constitutes 37 percent of the total population of the basin area. Figure 7 presents the population and population density of the DS divisions of the Deduru Oya.

About 95 percent of the population have a formal education. According to a survey carried out in 1994 a majority of people who had a formal education have completed secondary education (Grade 5–10). Fifteen percent have an education above G.C.E. (OL&AL), which is the senior secondary education level of the country.

Figure 7. Population and population density in DS divisions in Deduru Oya.



Employment

Agriculture is the major form of employment of 40–50 percent of the population in most of the DS divisions in the basin. Private-sector employment accounts for 10–22 percent of employment in most of the DS divisions while the public-sector employment ranges from 7 to 25 percent. The other main income-generating activities in the basin are trade, self-employment, fishing and animal husbandry. Many people depend on fishing in the DS divisions, as in Arachchikattuwa and Chilaw in the coastal area, in the tail end of the basin.

Economic Activities

The economy of the Deduru Oya basin is predominantly agricultural. Coconut and paddy are the main crops cultivated in the basin. Most of the river basin falls within the area known as the "Coconut Triangle," the area in which coconut cultivation flourishes. Analysis of data on land use in 14 DS divisions shows that more than 50 percent of land in 6 (43%) DS divisions, 40–50 percent of land in 4 (28%) DS divisions, 30–40 percent in 2 (13%) DS divisions and 20 percent in another 2 (13%) DS divisions are under coconut cultivation. Most of the coconut lands are smallholdings below 2 acres. For example, in most of the DS divisions more than 80 percent of coconut lands are below 2 acres in extent. It is a main income source providing a regular cash flow to the smallholding peasants in the basin. However, due to land fragmentation and unregulated felling of coconut trees, coconut cultivation is likely to diminish in significance in the near future.

Paddy cultivation is another means of livelihood of the people in the basin. It is cultivated under major and medium tank and anicut systems, small village tank and anicut systems and also under rain-fed conditions.

Livestock

Livestock farming is also an important means of livelihood for some households in the basin. There are livestock farms of different scales raising cattle, goats and poultry. The availability of grazing facilities in coconut lands has helped promote cattle farming. The data collected from seven DS divisions representing head-, middle- and tail-end areas of the basin show that cattle and poultry farming are successfully implemented all over the basin, especially in areas like Ibbagamuwa, Kobeigane, Bingiriya and Chilaw.

Industries

As one can expect, the main industries in the basin are paddy and coconut-based. Intensive data collection on industries in ten DS divisions shows 364 coconut-based industries and 566 rice-based industries. The rice-based industries are greater in number in major irrigation scheme areas, while more coconut-related industries are found in areas like Bingiriya where there are large coconut estates.

Shrimp farming is the main activity in the tail-end part of the river basin. There are a large number of shrimp farms in Chilaw and Arachchikattuwa DS divisions in the basin. For example, in 1977, there were 126 and 73 shrimp farms in Arachchikattuwa and Chilaw, respectively. They differ in scale; some shrimp farms are more than 50 acres in extent. Shrimp farms are located in the coastal zone of the basin. They have created some environmental problems for the coastal ecosystem. The water management projects, especially agricultural schemes, are located in the middle and head of the basin and therefore, these water management projects have not created any negative impacts on the performance of shrimp farms. Many of them operate without the approval of the relevant authorities. Since this is an industry bringing in foreign exchange, some operate with the approval of the Bureau of Investment (BOI).

Sand mining, brick making and tile making are also major industries in the area. Sand-mining activities can be observed from Ridigama DS division up to Chilaw. Members of the poor village communities work in these sand-mining industries operated by some big businessmen. Due to the informal nature of the operation there are no data on the number of people employed and the scale of operation. Brick- and tile-making activities are observed in Chilaw, Arachchikattuwa, and Ganewatte areas. In the 10 DS divisions intensively studied, there are 15 tile-making industries and 104 brick-making industries.

Income and Poverty

Families earning below Rs.1,500 per month (US$1=Rs83.5) are regarded as members of absolute poverty groups by the government, which pays an allowance called *samurdhi* to such people. (The beneficiary families for the samurdhi program are chosen, based on their monthly income. No other criteria are used to select them. The international criteria such as calorie intake are not adopted to select beneficiaries. On the other hand, such data are not available in government offices in the basin area.) According to data on samurdhi beneficiaries available

at government offices, more than 60 percent of the families in the basin belong to the absolute poverty group. There are some suburban areas and dry-zone areas where more than 80 percent of families are in the absolute poverty group. High population density, widespread unemployment, and very small landholdings characterize these pockets of poverty in the suburban areas. The pocket of poverty in the dry zone areas is characterized by the dependency on paddy cultivation under minor irrigation systems, low productivity and low cropping intensity. It can be observed that shortage of land and water resources is the main reasons for poverty in this river basin.

Performance of Irrigation Systems

Performance of irrigated agriculture in a given geographical area in the basin is dependent upon the seasonal rainfall and access to water in the river or its tributaries. Performance varies from system to system within the basin. The performance of the irrigation system is assessed here using indicators such as cropping intensity, yield and water duty. Comparisons are made between irrigation systems based on the size of the systems and management systems adopted in them. In Sri Lanka, irrigation system are categorized by the size of the command area into major and minor systems, above 80 hectares as major and below 80 hectares as minor. The government manages the major and medium schemes in Sri Lanka jointly with the farmers, while minor tank systems are farmer-managed.

Major systems in the basin include the Batalagoda tank, Magalla Wewa (Ride Bedi Ella), and Hakwatuna Oya and Kibulwana Oya schemes. There are about 6,000 hectares of paddy lands under these systems. Medium schemes include Karawita, Meddakatiya, Wennoruwa and Hulugalla tank systems, and several anicut (diversion weir) systems like Kospothu Oya. Command areas of these systems are around 1,000 hectares each. Another most important sector in paddy agriculture is the small village-tank systems. There are about 3,228 small tank systems providing subsistence to village communities in the basin.

Seasonal Cropping Intensity of the Basin

As can be observed from table 5, the cropping intensity is higher in major irrigation systems, which have a more reliable water supply than that in water-short minor systems. For example Ridi Bedi Ela (Magalla) and Batalagoda have 175 percent cropping intensity. Table 5 shows the average seasonal cropping intensity in major, medium and minor irrigation schemes located in the basin. In major irrigation schemes, the average annual cropping intensity is about 1.75 or a little more. Interviews with farmer leaders indicate that it can be increased up to 2 .00 if the water management is further improved. But the cropping intensity in small schemes cannot be increased substantially due to water scarcity during dry seasons. These systems cannot achieve 200 percent cropping intensity due to water shortage in the yala seasons. Although water is not a serious problem for these schemes, the tail-end farmers face water shortage due to poor water management and problems in the physical system. Kibulwana Oya is a water-abundant scheme with 200 percent cropping intensity. As Kibulwana is better-managed with farmer participation, water-related problems are not serious in this system.

A major problem in minor tank systems is water shortage for the yala (dry) season cultivation. Some tank systems face water shortages towards the end of the season. Cropping

Table 5. Cropping intensity.

Year	1994	94/95	1995	95 /96	1996	96/97	1997	97/98	1998
Season	Yala	Maha	Yala	Maha	Yala	Maha	Yala	Maha	Yala
Climatic Condition	Dry	Average	Wet	Dry	Average	Dry	Wet	Wet	Wet
Major irrigation	0.77	0.98	0.78	0.96	0.53	0.91	0.52	0.98	0.66
Minor irrigation	0.41	0.78	0.61	0.39	0.17	0.64	0.35	0.97	0.27
Rain-fed	0.19	0.86	0.63	0.25	0.16	0.78	0.53	0.95	0.28
Overall	0.39	0.84	0.65	0.43	0.23	0.74	0.45	0.97	0.34

intensity in these systems varies from 100–150 percent depending on their geographical locations. For example, in tank systems in areas like Ridigama and Bingiriya in the intermediate zone, the cropping intensity is about 150 percent while it is 100–120 percent in areas like Kobeigane, Wariyapola and Kotawehera, which are areas in the dry parts of the intermediate zone. Also due to the weakness of farmer organizations, farmer participation in O&M is weak in these systems and, as a result, water is not efficiently managed. Silting and sedimentation of tanks and development activities in the catchment areas have threatened the sustainability of tanks.

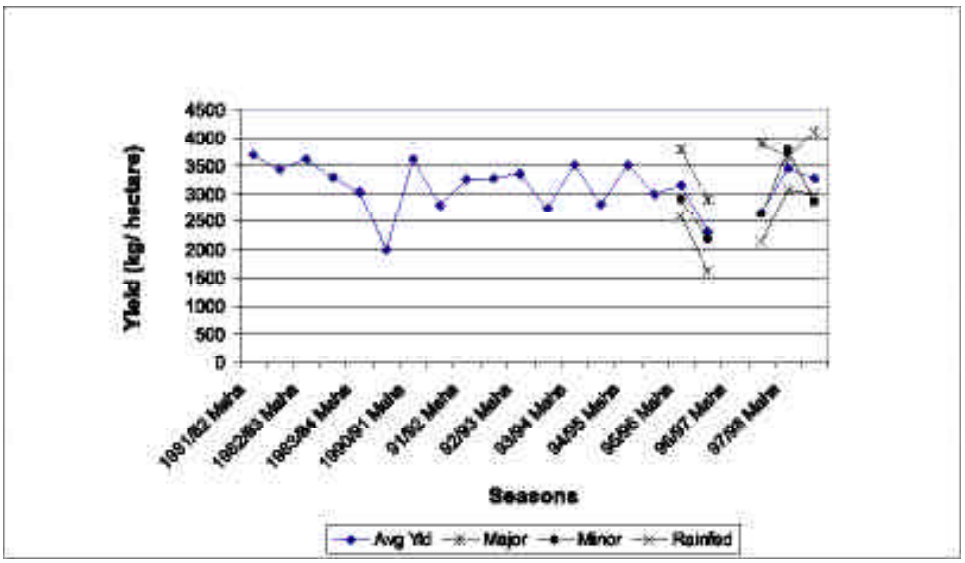
Yield Performance

The average paddy yield (kg/ha) in the Kurunegala district is given in the Statistical Abstract published by the Department of Census and Statistics and in figure 8. The average yield in the Kurunegala district, a large part of which falls within the basin, ranges from 3,000 to 3,400 kg/ha. The yield values for major and minor irrigation systems show that the yield ranges from 3,000 to 4,000 kg/ha and from 2,100 to 2,900 kg/ha in major and minor systems, respectively. Clearly, this indicates that yield is comparatively high in major irrigation systems with a reliable water supply.

The data obtained from the household survey carried out in small tank systems show that cultivation under small tank systems has become less profitable and less attractive with the increased cost of inputs, particularly farm power and labor. The survey further highlights that there is a significant change in income sources of people in these tank systems compared to the situation that prevailed 10 years ago. The number involved in agriculture has been reduced by 21 percent while there is a 16-percent increase in private- and public-sector employment in rural villages in the basin. The data are indicative of a trend among the youth to seek employment outside agriculture due to its less-rewarding nature and lack of social recognition.

In addition to water shortage and the high cost of production, paddy farmers face such problems as shortage of good-quality fertilizer and agro-chemicals that affect the performance of paddy cultivation. In addition, they face marketing problems and lack access to new farming technologies developed at research stations.

Figure 8. Average paddy yield in the Kurunegala district.



Water Use Efficiency in Major Irrigation Schemes

Data on water duty, obtained from the Department of Irrigation, for major irrigation schemes in the Deduru Oya basin are given in table 6. The data indicate that water duty is higher in the yala seasons than in the maha seasons when the basin experiences high rainfall.

Table 6. Water duty.

Season	Kimbulwana Oya Scheme	Batalagoda Scheme	Hakwatuna Oya Scheme	Magalla Scheme
1996/97 maha	na	na	0.8 m / ha	na
1997 yala	na	1.7 m / ha	1.5 m / ha	na
1997/98 maha	na	na	0.4 m / ha	na
1998 yala	na	na	na	na
1998/99 maha	na	na	na	na
1999 yala	1.7 m / ha	na	0.9 m / ha	na

Source: O&M Branch, Dept. of Irrigation; na = data not available.

When the performance of the jointly managed major and medium systems is compared with that managed by farmers shows that jointly managed systems perform better. However, this is not due to the difference in the management systems. The key factor for low productivity and low cropping intensity in minor systems is water shortage due to lack of a reliable water source. Also the subsistence-oriented farming communities in small village tank systems always try to avoid risks. Unreliability of rainfall in the yala season drives them to avoid cultivating their lands in this season. This results in low cropping intensity in those tank systems. The farmers face water shortage even in maha towards the end of the season, as they do not attend to paddy cultivation activities with the onset of rain. They first attend to highland cultivation, which is more reliable and productive. They get low yields in the maha seasons too due to this reason. No data are available on water duty in minor tank systems to compare them with those in major systems for water use efficiency. However, it is generally believed that water use efficiency in minor systems is higher than that in major systems.

Cultivation under Wells and Lift Irrigation

According to the Agriculture Development Authority, the institution dealing mainly with agricultural wells, there are 2,453 agricultural wells in 20 DS divisions. Data and information collected show that these wells are not fully utilized or the cropping systems proposed for them are not adopted due to various socioeconomic reasons and water-related problems. Some water from wells intended for agriculture is used for brick- making because it is more profitable than cultivation of OFCs.

Lift irrigation systems using water pumps to tap water from the Deduru Oya and its tributaries can be observed from the head to the tail-end part of the basin. There are three lift irrigation schemes cultivating paddy in the Kobeigane and Bingiriya areas. In addition, there are a large number of water pumps used for both paddy and OFC cultivation. The problems that farmers face using agro-wells and lift irrigation for agriculture include water scarcity and salinity, and problems related to the marketing of their crops.

Institutional Characteristics

The nature of the institutions involved in the development and management of water resources, their roles and functions and problems encountered by them in the execution of prescribed roles and functions are described in this section. The organizations involved in water resource management, policies, rules and regulations in force in the country for managing water and other natural resources and the involvement of community-based organizations (CBOs) are also discussed.

Government Institutions Involved in Development and Management of Water Resources

Though positive policy reforms are occurring in the water sector at present, no institution with responsibility for overall management of water resources has been set up as yet in Sri Lanka. More than 20 sectoral departments and agencies exist at the level of the central government for water resources administration and management. The most important national administrative bodies and institutions involved in the management of water and other natural

resources include ministries such as the Ministry of Irrigation and Power, the Ministry of Agriculture and Lands, the Ministry of Forestry and Environment, the Ministry of Mahaweli Development, and the Ministry of Fisheries and Aquatic Resources at central-government level. The most important departments and government bodies functioning under these ministries at central-government level are the Irrigation Department (ID),[2] the Department of Agrarian Services (ASD), the Irrigation Management Division (IMD), the National Water Supply and Drainage Board (NWS&DB), the Water Resources Board (WRB), the Agricultural Development Authority, the Forest Department, the Inland Fisheries Development Authority, the Coastal Conservation Department and the Geographical Survey and Mines Bureau of (GS&MB).

In 1987, an amendment (Thirteenth Amendment) was introduced to the constitution of the country devolving power and authority enjoyed by the central government to the newly established provincial councils and the administrative bodies, organizations and institutions formed under the provincial administration. After these changes, the provincial-level departments under provincial ministries carry out the water and other resource-management tasks within the powers and authority vested in them. At the local level, local government bodies like the urban councils, municipal councils, and pradesheeya sabhas also perform water-management functions related to domestic water.

The ID is responsible for the planning, design and construction of major and medium irrigation schemes. It is also responsible for the O&M of the system above the distributary channel level. The IMD is responsible for the coordination of the agricultural-plan implementation, initiation of Farmer Organizations (FOs) for tertiary system management and also for strengthening of FOs for joint management activities through project committees formed in major irrigation systems. Similar arrangements also exist in medium irrigation schemes through the joint management committees under the Management of National Irrigation Systems (MANIS). The communities themselves manage small village tank systems. The ASD handles institutional development activities in village tank systems.

The NW&SDB is a national-level agency responsible for domestic and industrial water supply, sewage and surface drainage. It is involved mainly in developing drinking water supply schemes. Activities of the WRB are limited to carrying out hydrological investigation of groundwater resources and groundwater resource development. The roles of these two institutions are limited to those of users and have no role in control of groundwater extraction and use.

The National Environmental Authority is the institution responsible for the enforcement of laws, rules and regulations in the Environmental Act to control the pollution of water and other natural resources. The power vested in the Environmental Authority has been delegated to Provincial Councils at present, enabling the provincial authority to play an important role in environmental protection. The Coastal Conservation Department is the agency responsible for the protection of natural resources and environment in coastal areas.

Apart from these organizations, there are a large number of organizations involved in agriculture and natural resources management activities. The Electricity Board can use water resources in the country for hydropower generation. The Mahaweli Authority is involved in water resources development activities in the Mahaweli system areas. Other institutions

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[2]In November 2000, a reorganization of Ministries occurred, and accordingly the ID comes under the new Ministry of Irrigation and Water Resource Management.

involved include District Secretaries at District level and Divisional Secretaries at divisional level with authority over land and irrigation management activities and coordinating responsibilities. Others include the Department of Agriculture (DOA), the Department of Animal Production and Health (DAPH), the Samurdhi Authority (attached to the Divisional Secretary's office), the Coconut Development Board, the Agriculture Development Authority, the Forest Department, the Department of Inland Fisheries, and the Cashew Cooperation and Minor Export Crop Development Department. The local government bodies like pradesheeya sabhas, municipal and urban councils also have roles in water resources development in areas under their jurisdiction.

The CBOs functioning in the basin are mainly the FOs in small tank systems, medium and major schemes, *kapruka* societies formed recently by the Coconut Development Board, multipurpose cooperative societies, milk producers' cooperatives, cooperative societies formed by farmers engaged in poultry farming, samurdhi associations formed by the Samurdhi Authority and the Environmental Associations formed recently by the Environmental Development Assistants working in the DS offices. However, these CBOs were found to be extremely weak, lacking capacity to attend to the resource- management tasks effectively.

Since the institutions involved in water resources management and agriculture are numerous they require coordination mechanisms at different levels to successfully plan and implement water- and agriculture-related activities. The coordinating committees functioning at present includes the Agrarian Service Committees, and AMA Committees (committees established to coordinate agricultural development at field level) at the Agrarian Centre level. They are held with the participation of field-level officers of line agencies and farmer representatives. In each DS division there is a DS level Agricultural Committee (DSAC) attended by a limited number of farmer representatives and line agency officials working in the DS division. Above the DS division level there are District Agricultural Committees (DACs) in each district. This committee is chaired by the District Secretary and is attended by line agency officials working at district level and farmer representatives from major, medium and minor irrigation systems. Forest Protection and Law Enforcement Committees (Environmental Committee) are at DS and district levels. These committees are held after the monthly meeting of the DSAC and DAC with the participation of officials attending these two committees. The major function of this committee is the protection of forest resources.

Other coordinating committees include electorate-level committees chaired by Members of Parliament of the respective electorates to plan and monitor infrastructural and agricultural development activities in the electorates. Officials of agencies working in the electorate attend these meetings. At the district level there is a District Level Development Committee chaired by the Chief Minister of the province to plan and monitor the development activities of the district.

National Policies, Rules and Regulations on Natural Resources Management with Special Emphasis on Land and Water Resources

Policies. Up to very recent times, the government policy for water resources development was the construction of large-scale new irrigation settlement projects and rehabilitation and renovation of the existing schemes to achieve self-sufficiency in rice, income generation and employment for the growing population. Surface-water resources were owned by the state. The O&M of major and medium irrigation were also a state responsibility. Water users remained

passive recipients of the benefits. Handing over larger responsibilities of O&M of the irrigation system to farmers and improving efficiency in irrigation water management in existing irrigation systems through farmer participation have become the government policy since 1988.

In the past, the government policy was directed at the development of the irrigation sector and there was no attempt to address all the matters related to water in a holistic manner through appropriate policy measures. The newly established Water Resources Secretariat (WRS) has already developed policies in this direction for which the approval of the Parliament has also been obtained.

Rules and regulations. A large number of rules and regulations exist for the development and management of water resources. They empower different government agencies to develop and manage water and land resources or to control pollution of natural resources. The authority and power vested in the organizations through these acts overlap. They include the Irrigation Ordinance No.32 of 1946, Crown Land Ordinance (State Land Ordinance) of 1947, and the Electricity Act No.19 (as amended in 1950). There are also land laws and environmental regulations aiming at the proper use and control of land, water and other natural resources.

Institutional problems. Institutional problems in the basin can be observed at different levels. The main problems related to the organizations include:

- The power and authority over water-related matters are vested in different agencies through various acts and regulations. There is no institution with overall responsibility over water resources management.
- The responsibilities of the existing water institutions often overlap, as they have been created to address specific needs at certain periods of time.
- The power and authority over natural resources management and environmental protection have not been decentralized. This is a serious problem for the DS level government agencies and local government bodies in effectively attending to the natural resources management tasks.
- Lack of resources for the Agrarian Centre level and DS level committees and local government bodies to attend to resources management tasks effectively.
- Lack of interest on the enforcement of laws relating to natural resources management.
- Intervention by politicians in natural resources management activities.
- Lack of commitment of some government officials and their inefficiency.
- Weaknesses of existing CBOs like FOs, Environmental Committees, etc., to effectively attend to resources management activities.

A major institutional problem related to coordinating mechanisms at different levels, such as ASC, DS, and district levels, is that even though they play an important role in implementing

the agricultural plan, their effectiveness in managing natural resources like riverine resources, forests, lagoons and the environment at large is minimal. Also they have the following problems regarding integration:

- The DS level Agricultural Committee (DSAC) has no resources, power or authority to deal with problems related to natural resources management problems or to implementation of the agricultural plan. It is just a committee and not a legal body.
- The ASC-level committees like the AMA (the coordinating committee at the ASC level) do not function, as they have no benefit to offer to the farmers. Divisional Officers of the ASD have no authority over agency officials to get their participation at these coordinating meetings.
- Departments and ministries do not adopt integrated approaches at the level of their headquarters. It cannot be adopted at the DS or ASC level due to this reason.

The following problems are observed in existing legislation:

- Duplication and overlapping of functions of the institutions due to empowering of different institutions with the same function through different enactments.
- Loopholes in government acts on land and water resources and environmental protection.
- Lack of clear policies, rules or regulations for water allocation among different sectors or over water rights.

Conclusions and Recommendations

As highlighted above, the main resource constraint in the basin is the temporal and spatial nature of its water scarcity. The spatial water scarcity in the basin is mainly due to its spread in different agro-climatic regions, such as intermediate and dry zones. The temporal water scarcity is due to the shortage of rainfall in the yala season. Low cropping intensity and low productivity, reported in medium and minor tank systems as well as in major schemes like the Hakwatuna Oya result from water scarcity. The major resource management problems observed in the basin are the pollution of surface water and groundwater, depletion of groundwater, erosion of river banks and stream reservations (a reservation is the portion of land adjacent to the river and its tributaries that is reserved to protect the riverbanks and river-related ecosystem), soil erosion in tank catchments and sedimentation. Surface water is polluted as a result of discharge of wastewater and pollutants to irrigation canals, streams and watercourses. This is mainly an urban phenomenon. The authority over enforcing regulations relating to this is vested with the Central and Provincial Environmental Authorities, Urban Councils or Municipal Councils depending on the scale of industries or enterprises causing such pollution. Groundwater pollution is reported mainly in coastal areas due to seawater intrusion along the river, due to sand mining and excessive extraction of ground water using tube wells. Lack of clear policies, rules and guidelines for extraction of groundwater is a major institutional constraint leading to groundwater pollution.

The major cause of groundwater depletion is unregulated sand mining in the river and its tributaries. The riverbeds have deepened due to unplanned and excessive sand mining in rivers and their tributaries. As a result, the level of the river water is lowered, especially during the dry season. This, in turn, has resulted in decreasing the water levels in the shallow wells constructed close to the riverbanks. It is understood that the Mines and Mineral Act provides sufficient authority to arrest this problem but the problems in implementing regulations are with the bureaucracy at the central government level and not with agencies operating at field level. This highlights the necessity of devolving power and authority to institutions at provincial and DS levels for them to effectively attend to natural resources management activities.

Common properties like stream reservations and tank catchments are formally considered to be state property, though there may be some privately owned lands among them. Divisional Secretaries have power and authority to take action against encroachments on such property. But various political and social pressures and resource constraints hinder them from attending to these activities. Also, there are no special programs to stimulate community members to take over and manage these common properties through tree planting and other soil conservation measures.

Other than these resource management problems, inefficient water management is reported from major and medium irrigation systems. If the proposal for the construction of a new reservoir in upstream areas is implemented, Batalagoda and Redi Bedi Ela schemes cannot expect an abundant supply of water. This will require better water management on the part of the irrigation managers and farmers in these schemes. In minor tank systems, there are no special efforts to assist farmers to use water efficiently through management innovations, to avoid crop failures and low yield due to water scarcity towards the end of the season. During most months of the year, certain portions of the river are dry, creating water-scarcity problems. This situation will be aggravated in the future with the increasing competition for water from other uses such as industries and the domestic water supply.

If we examine the present government policies, they indicate a shift of focus from the government's earlier approaches for water resource development and management. Many changes are taking place in the policy arena and institutional reforms are underway to address some of these issues. Following the steps taken by many countries that faced water-related problems, such as water pollution, withdrawal of freshwater and water scarcity, Sri Lanka too has shifted its focus from the development of irrigation schemes to the management of the basin to achieve water conservation and protection of quality of water for the use of agriculture and other sectors. The government is concerned with handing over the resource management responsibilities completely to the beneficiaries of irrigation systems even though the emphasis in previous decades was on joint management with them. We recommend the government address the institutional problems at the national level by adopting the following policy measures:

- Setting up of a Water Resource Council to address all matters related to water in a holistic manner. This is in progress at the moment.

- Development of a master plan for water usage. Steps need to be taken to develop a water allocation policy to make optimum use of available water resources, to cater

to competing demands of different sectors like irrigation and power generation in a sustainable way.

- Development of comprehensive river basin plans for major river basins.
- Handing over of larger responsibilities over O&M of irrigation systems to farmers, and improving efficiency in the management of irrigation water in existing irrigation systems through farmer participation.
- Increasing productivity in existing irrigated land through crop diversification and higher cropping intensities.
- Rehabilitation of irrigation systems.
- Development of criteria for assessing groundwater resources and development of ground water resources for agricultural and domestic uses.
- Expansion of programs for water supply and sanitation to provide adequate drinking water and sanitation facilities.

In addition to these, the following institutional reforms are required at the field level to address the problems at the field, DS and district levels:

- Strengthening of District- and DS-level agricultural committees as coordinating bodies for water and other natural resources management by introducing necessary amendments to existing rules and regulations.
- Introducing provisions to make the concerned line agencies to be accountable to the committees.
- Establishment of monitoring cells at District and DS levels to monitor the progress of resources management activities.
- Introducing clear procedures for evaluating and rewarding the performance of line agency officials.
- Introducing necessary amendments to the Acts and Ordinances for the smooth functioning of the proposed committees.
- Institutional development at ASC level for better O&M of minor irrigation systems.
- Demarcation of river reservations through surveys to arrest widespread encroachments on riverine resources and other common properties.
- Handing over of common properties like tank catchments and reservations for conservation to the farmer communities.
- Creating awareness among national-level and local-level politicians about problems related to the management of natural resources.